

practical importance to the plant. I am inclined to believe, from Sachs'* experiments on the depletion of leaves, that all saving of heat must be valuable, by preventing the checking of translocation which he observed on cold nights.

The mechanism of the stoma is another subject which does not lend itself to condensed treatment. I have tried to point out that the stoma has been neglected in the modern reorganisation of plant physiology from the point of view of irritability. Some observers insist on the preponderant influence of the guard cells, while Leitgeb in the same way exaggerated the importance of epidermic pressure, whereas the two factors should, as far as possible, be considered as parts of a whole and as correlated rather than opposed in action. I have also attempted to show how the stoma, like other parts of the plant, may be supposed to react adaptively to those signals, which we usually call stimuli. The attempt which I have made to rank the problem among the phenomena of irritability, is very tentative in character. I have ventured to put it forth because I am convinced that it is in this direction that advances will be made.

“Mathematical Contributions to the Theory of Evolution. V.

On the Reconstruction of the Stature of Prehistoric Races.”

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(Abstract).

1. The object of this memoir is to illustrate the general theory by which we may reconstruct from the knowledge of one organ in a fossil or prehistoric race, the dimensions of other organs, when the correlation between organs in existing races of the same species has been ascertained. The particular illustration chosen is the reconstruction of probable stature from a measurement of the long bones.

Up till quite recently this subject remained in great obscurity, partly on account of absence of theory, and partly for want of trustworthy data.

2. The estimated statures as obtained by Orfila, Topinard or Beddoe, or by use of their methods, differ widely, and those methods have no satisfactory theoretical basis. It was usual to suppose that there was some mean or average ratio of stature to long bone, and even when it was recognised that this ratio varied with the length of the long bone, it was thought sufficient to determine it for two or three separate ranges of stature, and determine its mean value for these ranges by a very limited number of cases.

* ‘Arbeiten,’ 1884.

3. The first stage in advance was taken when Rollet published his measurements made in the Anatomical Theatre at Lyons, of the stature and long bones of 100 corpses. Rollet's attempt to establish ratios on the basis of his measurements is not very satisfactory, but to him belongs the credit of having first provided a respectable, if not large amount of data. Rollet's work was followed by a very able memoir on the reconstruction of stature by Manouvrier. Rejecting about one half Rollet's data, he constructed tables giving the average stature for certain ranges of each of the six long bones, and further what he terms *coefficients moyens ultimes*, for ascertaining the stature corresponding to long bones lying outside the limits of his *tableau barème*. There are many traces in Manouvrier's paper of the old view of a "coefficient" by which the long bone must be multiplied in order to obtain the stature. Beyond this view, it cannot be said to contain any theory, and it suffers from certain marked defects. In the first place, proper allowance does not seem to be made for cartilage and the disappearance of animal matter from the bones. The 2 mm. allowed on each bone appear by no means sufficient. In the second place, Manouvrier does not seem to me to justify his extension of results obtained from the French to very divergent races. He merely remarks that individual variations are greater than ethnic. Even if this extension be made, it must be done with hesitation, and with a full recognition of the assumptions made. Lastly, we may note that the statures obtained from the different long bones by Manouvrier's table for particular races, are often rather widely divergent among themselves, and no attempt is made to account for this divergence.

4. Manouvrier's memoir was rapidly followed by an excellent piece of work from Rahon, who collected measurements of the long bones of a very wide series of local races of man, and reconstructed their stature by aid of Manouvrier's tables. This memoir will remain of first-class importance even if better reconstruction formulæ than those of Manouvrier are adopted. Manouvrier's tables have been used in recent German memoirs, as those of Nitsche and Kollmann on the skeletons of the Row Graves and of the *Schweizersbild*. They are accepted at present as the standard tables for the reconstruction of stature.

5. The present memoir starts with the theory of probability, which the author has already applied to other problems in evolution, and deduces the most probable stature for any combination of the four long bones. It is shown that for a population with normal correlation, the relation between stature and one or more long bones is always linear. A general theorem is proved to show that no linear function of the long bones can give the probable stature with so small a probable error as the regression formula of the theory of probability. From this result the following conclusions are obtained:

(a) No constancy of the ratio stature to long bone is theoretically to be expected, but the ratio of deviation from mean stature to deviation from mean long bone, *i.e.*, the regression coefficient is the quantity, the constancy of which might be expected.

(b) No method of predicting individual stature from the individual long bones, whether one or all are used, can give a result with a less probable error than 2 cm.

(c) For the same length of femur, tibia, and humerus, the stature is shorter the longer the radius. This result has considerable bearing on the relationship of man to the anthropomorphous apes.

6. Formulæ are then obtained for the reconstruction of probable stature as measured :

(a) On corpse, from the lengths of the long bones containing animal matter, and with the cartilages attached. These will possibly be of service for purposes of criminal investigation.

(b) In life, from the lengths of the long bones without cartilages, and free of all animal matter.

Corrections are given for cases in which the femur is measured in the oblique position; the tibia is measured with the spine; and the left, instead of the right, hand members are known.

7. While the formulæ are tested on twenty cases, taken at random from Rollet's data, with fairly satisfactory results, the step from variation within the local race to racial variations is not made without a consideration of the circumstances under which natural selection will modify a regression formula. It is pointed out that the divergence between such regression formulæ really enables us to predict to some extent the nature of the differential selection which has taken place between two local races. To test how far we may safely apply our formulæ to other than French measurements, the stature of the Ainos ♂ and ♀ is reconstructed by means of them from Koganei's measurements of the long bones, and the result is found to be very satisfactory. If French regression formulæ give good results for the Aino, they will give, in all probability, good results for prehistoric European races. At the same time it is most important that material should be obtained for an independent investigation of the regression formulæ for another European race. With a view of illustrating the change in the regression formulæ owing to selection, the anthropomorphous apes are considered, and it is shown that the gorilla, in the regression formulæ for femur and tibia stands much closer to man than either the chimpanzee or orang.

8. The formulæ are applied to reconstruct the stature of Palæolithic man, Neolithic man in France and Britain, of the Dolmen-builders and Guanches, of Round Barrow British, and Row Grave Germans, of Romano-British and Romano-Gauls, of Anglo-Saxons, Franks, mediæval French, and of the Naqada race discovered by Professor

Petrie, and measured by Mr. Warren. The modern populations occupying the same districts of Europe as Palæolithic and Neolithic man appear to be taller, but in the case of both south Germany and France there appears to be a slight, but sensible, decrease of stature since prehistoric times. Modern English do not seem to have decreased in stature since the ancient Anglo-Saxons. In the estimates of stature for the above races, the author differs, in some cases very considerably, from previous writers.

9. Beyond the range of normal population (say from 157 to 175 cm. for ♂), the line of regression ceases to be linear. An attempt is made, such as existing data will allow of, to express the line of regression by the equation to a curve. The constants of this curve are determined for measurements of the four chief long bones, and the results exhibited in a diagram, from which it is possible to deduce the probable stature corresponding to a given length of any long bone by inspection. The prediction of the stature of dwarfs from the curve obtained from the data of giants shows only 2.25 cm. mean error, and must be considered satisfactory. Application is then made of the results to reconstruct the stature of Bushmen, Andamanese, and Akkas. These give sufficiently good results to lead us to believe that a fair estimate can be made of the stature of European neolithic dwarfs.

The memoir concludes with a table of reconstructed statures and sexual ratios.

“The Nature of the Antagonism between Toxins and Antitoxins.” By C. J. MARTIN, M.B., D.Sc. Lond., Acting Professor of Physiology, and THOMAS CHERRY, M.D., M.S. Melb., Demonstrator and Assistant Lecturer in Pathology in the University of Melbourne. Communicated by W. D. HALLIBURTON, F.R.S. Received May 7—Read June 9, 1898.

In the ‘*Deutsche Med. Wochenschrift*’ for 1894 appeared a controversy on this subject between Behring and Buchner. Behring maintained that the antagonism was of a chemical nature, and that the antitoxin neutralised the toxin much as an alkali neutralised an acid. Buchner, on the other hand, adduced results opposed to this view, pointing to the interpretation that the action was an indirect one, due to the antitoxin operating in some indirect way through the medium of the cells of the organism. Since this controversy many investigations have been made with the object of deciding this fundamental point. At the present time, however, opinion is still divided;